Space Weather Technical Forecast

Issued on Thursday, 07 December 2023 at 01:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of further isolated M-Class flares (R1-R2 Blackouts) throughout. Chance of Active fluence day 1, then likely from day 2.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is currently Moderate with two M-Class flares in the past 24 hours, with a peak M2.3 at 06/2144 UTC which originated from AR3513 in the northeast. There are currently nine sunspot regions on the visible disc. The most active region on the disc is AR3513 in the northeast. The viewing angle of this region is improving, showing some magnetic complexity. Two other larger regions on the disc are AR3510 and AR3511 close to centre disc in the south. There is a complex of regions in this area, with magnetic connection between these regions, though spots appear to be spreading laterally. AR3507 in the northeast has more of a north-south magnetic alignment, perhaps increasing instability. The other regions on the disc appear mostly smaller and simpler at present.

A number of CMEs have been evident in coronagraph imagery during the past 24 hours, though none are currently deemed to have any Earth-directed component.

Solar Wind / Geomagnetic Activity: Solar winds as measured by ACE and DSCOVR at L1 show an ongoing but waning High Speed Stream (HSS) from coronal hole CH76/-. Wind speeds were strong, around 600-630 km/s but have gradually fallen back to elevated levels, around 550 km/s. Density has been below average throughout. The Interplanetary Magnetic Field (IMF), Bt, has been weak throughout at 5nT or below. The north-south component of the IMF (Bz), has varied weakly. Phi angle has been predominantly negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 2-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at background levels. GOES16 high energy (greater than 2MeV) electron flux was weak initially, rising to moderate levels through the second half of the day. The associated 24-hour fluence has remained below the Active threshold (1e8 integrated pfu), but with an upward trend. The observation at 07/0000 UTC was 2.52e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate with a chance of further M-class flares, mainly from AR3513, but perhaps also AR3507, AR3510 or AR3511.

Solar Wind / Geomagnetic Activity: The CME produced by a filament eruption around 04/0700 UTC is expected to miss Earth, however, there is a very slight chance of some enhancement and a glancing blow early day 1 (07 Dec). No further Earth directed CMEs feature in the forecast. Solar winds are currently at elevated levels (around 550 km/s) due to waning effects from CH76/-. Solar winds are expected to gradually decline through the coming days, with speeds likely to be near background levels by day 3 (09 Dec). On day 4 (10 Dec), there is a chance of the fast wind from CH77/+ arriving, perhaps bringing elevated winds speeds for a time, with speeds perhaps reaching 500-550 km/s once again.

Geomagnetic activity is expected to be largely Quiet to Unsettled (Kp 0-3). There is a slight chance early day 1 (07 Dec) that a glancing blow from a CME may produce an Active (Kp 4) or

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G1/Minor Geomagnetic Storm (Kp 5) interval. On day 4 (10 Dec), the arrival of CH77/+ may bring further Unsettled to Active (Kp 3-4) periods with a slight chance of a G1/Minor Geomagnetic Storm interval (Kp 5).

Energetic Particles / Solar Radiation: GOES16 high energy proton flux is forecast to remain at background levels, with just a slight chance of reaching the S1/Minor Storm level should there be any larger flares from the regions in the western hemisphere.

Electron flux is currently at moderate levels. An increase in electron flux, reaching high levels at the diurnal maxima is likely through the forecast period. However, the slight chance of a CME glancing blow early in the period somewhat reduces confidence in the forecast. The associated 24 hour electron fluence is most likely to increase through the coming days, with a chance of exceeding the Active threshold day 1 (08 Dec) becoming likely from day 2 (08-10 Dec).

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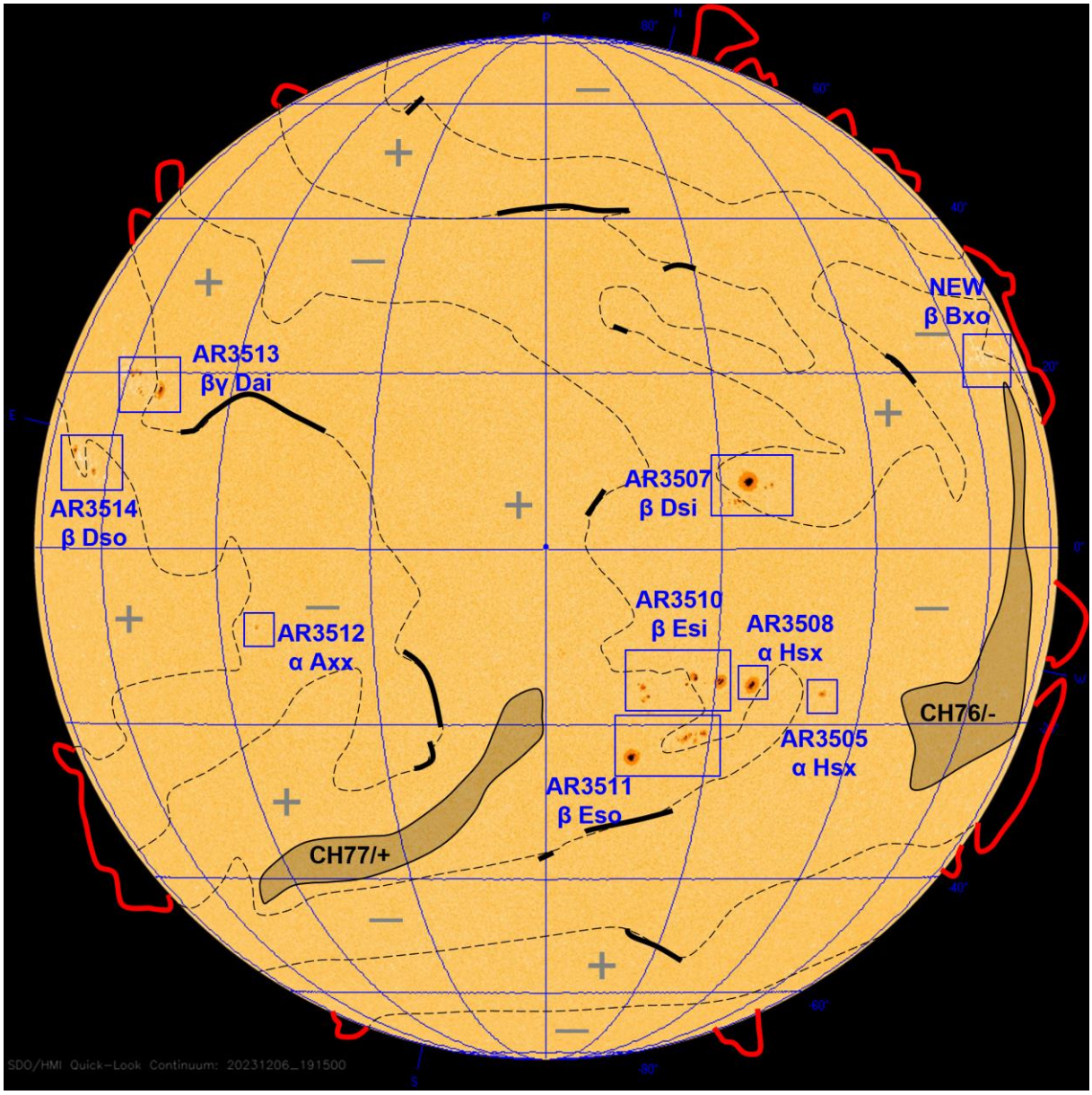
Figure 1. Solar Analysis Valid 06/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

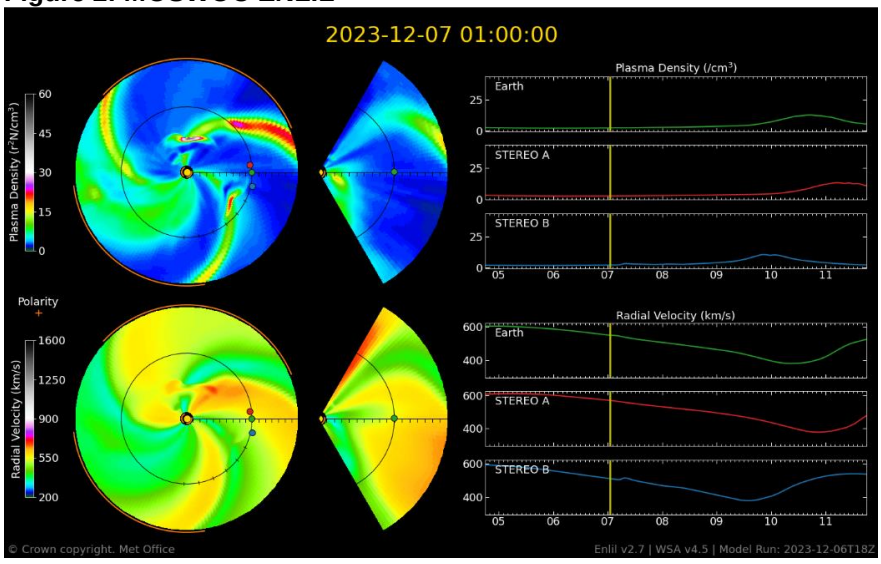
The CME produced by a filament eruption around 04/0700 UTC is expected to miss Earth, however, there is a very slight chance of some enhancement and a glancing blow early day 1 (07 Dec). No further Earth directed CMEs feature in the forecast.

Solar winds are currently at elevated levels (around 550 km/s) due to waning effects from CH76/-. Solar winds are expected to gradually decline through the coming days, with speeds likely to be near background levels by day 3 (09 Dec). On day 4 (10 Dec), there is a chance of the fast wind from CH77/+ arriving, perhaps bringing elevated winds speeds for a time, with speeds perhaps reaching 500-550 km/s once again. The leading edge of this feature is not clear in imagery, appearing ragged, and therefore the timing of this feature is lower confidence than usual. On the previous rotation similar speeds to what is forecast were observed. Enlil is currently providing good guidance on wind speeds.

Geomagnetic activity is expected to be largely Quiet to Unsettled (Kp 0-3). There is a slight chance early day 1 (07 Dec) that a glancing blow from a CME may produce an Active (Kp 4) or G1/Minor Geomagnetic Storm (Kp 5) interval but this is considered a low probability, with the majority of Enlil ensemble members modelling a clear miss. On day 4 (10 Dec), the arrival of CH77/+ may bring further Unsettled to Active (Kp 3-4) periods with a slight chance of a G1/Minor Geomagnetic Storm interval (Kp 5).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	1	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC ENLIL



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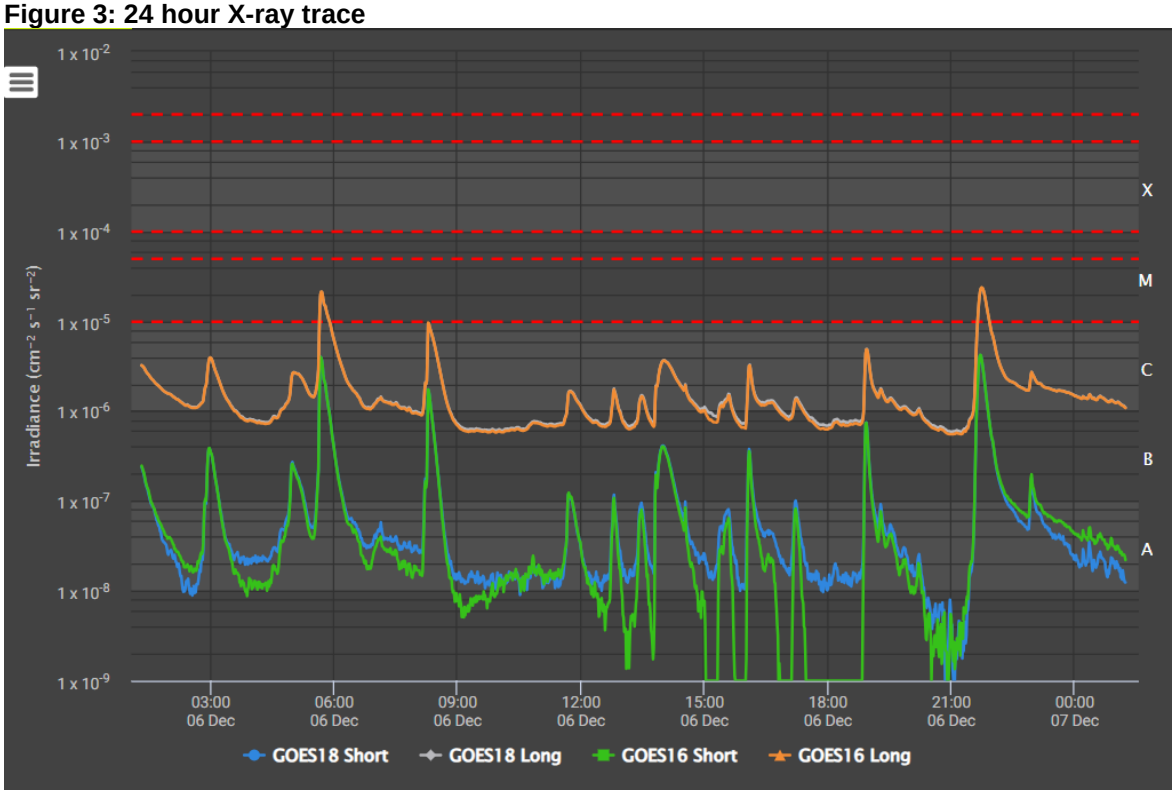
Radio Blackouts - X-Ray Flares:

There are currently nine sunspot regions on the visible disc. The most active region on the disc is AR3513 in the northeast. The viewing angle of this region is improving, showing some magnetic complexity. Two other larger regions on the disc are AR3510 and AR3511 close to centre disc in the south. There is a complex of regions in this area, with magnetic connection between these regions, though spots appear to be spreading laterally. AR3507 in the northeast has more of a north-south magnetic alignment, perhaps increasing instability. The other regions on the disc appear mostly smaller and simpler at present.

Solar activity is currently Moderate with the largest flare of the past 24 hours an M2.3 at 06/2144 UTC, which originated from AR3513. Low to Moderate activity is expected to continue with a chance of further isolated M-flares, mainly from AR3513, but perhaps also AR3507, AR3510 or AR3511. No significant regions are expected to rotate off the disc in the next four days, and far side seismographs are not showing any large regions due to rotate onto the disc. As such, the flare probability has been kept flat through the next few days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: 24 hour X-ray trace



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at background levels and is most likely to remain so in the next few days. There is a slight chance of S1/Minor Storm conditions being reached should any significant flares occur, mainly from AR3510 and AR3511 as they rotate further across the western disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

Electron flux is currently at moderate levels. The Van Allen belts are now relaxing as the supressing effects from CH76/- wane. An increase in electron flux, reaching high levels at the diurnal maxima is likely through the forecast period. However, the slight chance of a glancing blow early in the period somewhat reduces confidence in the forecast.

The associated 24 hour electron fluence is most likely to increase through the coming days, with a chance of exceeding the Active threshold day 1 (08 Dec) becoming likely from day 2 (08-10 Dec). REFM is considered to be providing reasonable guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	40	60	80	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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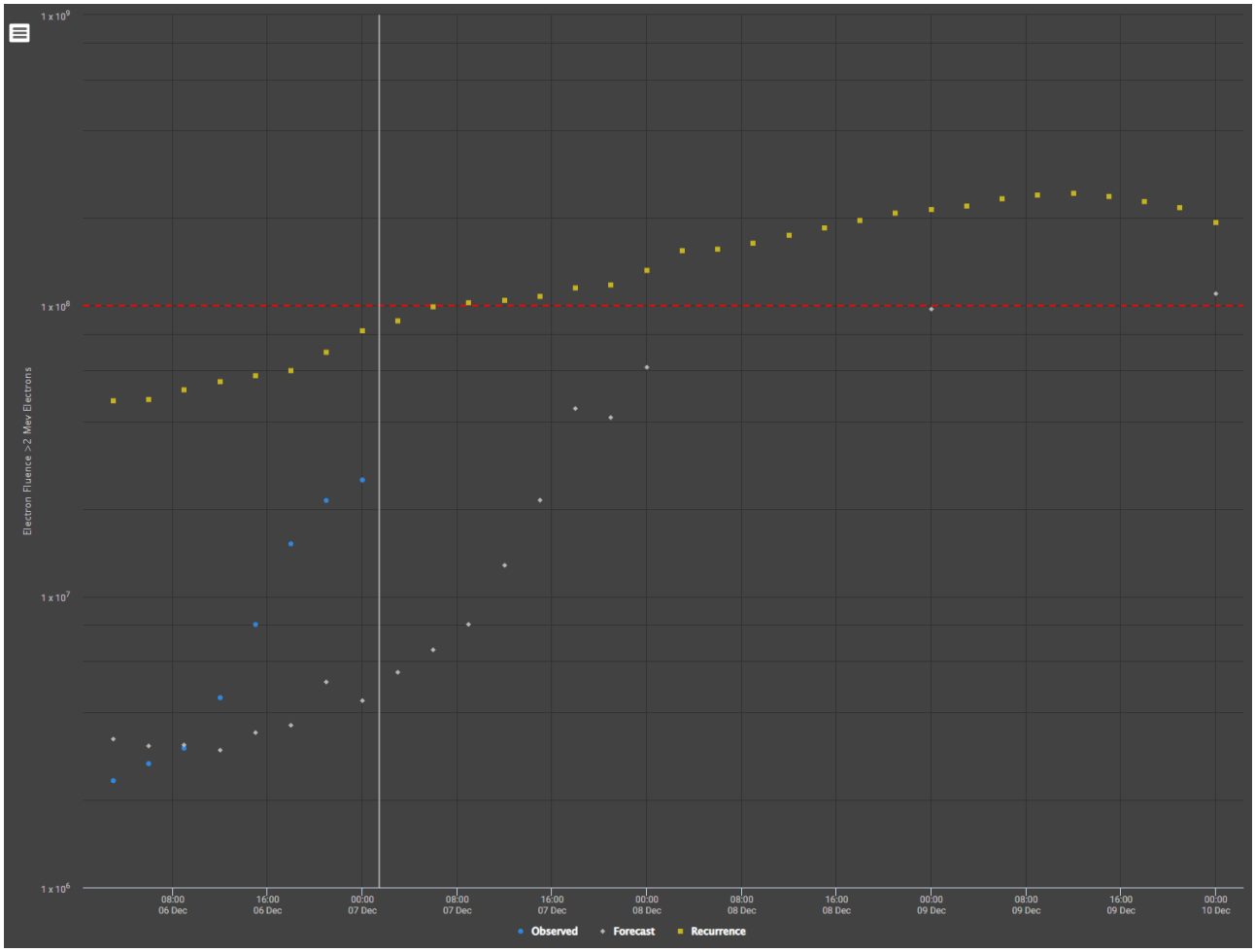
Figure 4: MOSWOC REFM integrated flux.



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